GODAE systems in operation

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ABSTRACT
During the last 15 years, operational oceanography systems have emerged in several countries around the
world. This emergence has been fostered primarily by the Global Ocean Data Assimilation Experiment
(GODAE), during which each nation engaged in this activity have organised partnership and constructive
competition. This multinational coordination was very beneficial for the development of operational
oceanography. Today, several systems provide routine realtime ocean analysis, forecast and reanalysis
products. These systems are based on (i) stateoftheart Ocean General Circulation Model

(OGCM) configurations, either global or regional (basinscale), with resolutions that range from coarse to eddy resolving and (ii) data assimilation techniques whose complexity ranges from analysis correction to advanced 3 or 4 dimentional variational schemes (3DVAR, 4DVAR). Altimeter sea level anomalies (SLA) , sea surface temperature (SST) data and in situ profiles of temperature and salinity, including Argo are assimilated. Some systems have implemented downscaling capacities including shelf/coastal regions. Others have implemented coupling with the atmosphere and/or the prognostic sea ice in Polar Regions. This paper provides a short review of these operational GODAE systems.

INTRODUCTION

The development of global and regional ocean data assimilation systems started in the nineties. This development was made possible because several ingredients were in place: (i) advances in numerical ocean modelling, with OGCM codes developed by the research community being available, successfully implemented and scientifically validated in realistic configurations, numerically efficient and with high coding and documentation standards, (ii) development of assimilation schemes for the ocean, successfully demonstrated in realistic applications, and with algorithmic simplifications allowing their implementation on the existing computers, (iii) the emergence of super computing facilities, enabling the implementation of realistic eddy resolving ocean data assimilation systems at basin scale, (iv) the development of global observing systems, with realtime data delivery mechanisms, including satellite altimetry that allowed to have a continuous, quasi synoptic picture of the global ocean eddy field. Finally, this development has been fuelled by users' demand, i.e., navies, meteorological agencies for applications including underwater acoustics, object drift monitoring, hurricane forecast, seasonal and climate prediction, and the downstream commercial sector such as the oil industry.

This movement started approximately at the same time in Europe and USA in the early nineties. In the USA, the Naval Research Laboratory (NRL) implemented a 1⁄4° global NLOM system in 1997 (Hurlburt et al., 2008). In Europe, the UK Met office implemented the FOAM system (Bell et al., 2000) in 1997 (global, 1°),

and the French Navy implemented the SOAP system (Giraud et al., 1997) in 1993 in the Azores current region (12.5km horizontal resolution), and extended to the Northeastern Atlantic (at 1/10°) in 1998. An increasing number of other countries have rapidly followed, and have developed realtime ocean prediction capacities including Italy and Norway in Europe, Japan, Australia, China and Canada. Today, a dozen systems are routinely operated in the 9 countries that participated in GODAE, from regional high resolution including tides to global eddy resolving systems, providing estimates of the ocean state updated regularly (from daily to monthly), and providing forecasts from a few days up to one month ahead.